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Dancing to the Tune of Opportunities –Human Settlements Aligned to Share the Jackpot of Kenya's Coastal Tourism Benefits Spoil the Broth

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Abstract
This paper highlights how human settlements aligned themselves to share the benefits to arise from coastal tourism development in the Kenya coast, but have come to bedevil the industry through poor management of domestic waste. The study area comprised of Nyali-Bamburi-Shanzu and Diani-Chale, which are two important tourist destinations in the country. It attempted to establish population numbers in these habitations, the waste loads generated, and how it was managed. The study was accomplished through field visits, library research and application of the World Health Organization (WHO 1989) rapid assessment methods for land, air and water pollution. The relevant data for assessment was obtained from records of population census, bed nights, occupancy, and the waste disposal methods in use. The study revealed that human settlements aligned themselves in clusters inland, reflecting the clusters of the beach hotels dotting the shore line of the Indian Ocean. Large volumes of domestic waste were being generated in both the human settlements and in the hotels. Management of the waste in the settlements was largely on-site and mixed, through the use of both pit latrines and septic-tank/soakage pit systems in the human settlements, and only through septic-tank/soakage pits in the hotel establishments. None of the settlements had wastewater treatment facilities. Only 5 beach hotels had wastewater treatment plants. While the settlements positioned themselves to benefit from the tourism industry, tapping in business and employment opportunities, the arrangement has seemed to spoil the broth as the settlements came to be the main source domestic waste affecting environmental quality and undermining tourism growth and sustainability. Also, through the large number of visitors, during the peak tourist periods, the beach hotels themselves have come contribute to large waste generation. On-site sanitation, it is concluded, is not appropriate for managing domestic waste in coastal areas dependent on good quality environmental to flourish the tourism economic sector. Tourism thrives in areas where the environment is aesthetically appealing; domestic waste undermine. Consequently, it is recommended that innovative approaches are pursued for domestic waste management in order to flourish and sustain the industry.
Keywords: Human waste, human settlements, tourism, on-site sanitation, contamination, aesthetic value, water quality, sustainability.

1 Background

Nyali-Bamburi-Shanzu in Kisauni District of Mombasa County and Diani-Chale in Diani location of the Kwale County, are two of the most frequently visited tourist beach destinations in Kenya. These two areas enjoy a beautiful climate and rainfall pattern in addition to hosting some of the most biologically diverse ecosystems in the country –attributes that have lured tourists to these areas. Consequently, they now constitute the most developed beaches in the country, dotting with world class hotels, and teeming with a plethora of tourist activities. To tap the benefits of the industry for livelihood and self-development, is a sizeable number of Kenyans, both local, and from other parts of the country, descending here for employment and opportunities for business, provided by the sector. The outcome is the growth of large human settlements with inadequate infrastructure to manage the human waste it generates. This paper reviews the development of tourism as the catalyst for the mushrooming of human settlements in the two areas; the human waste loads generated by the population, including the tourists; the human waste management practices in place, and their effectiveness, before conclusions are drawn on sustaining both tourism and urban settlement co-existence.

Favourable weather conditions is the other pull factor for tourism in these areas. The temperature range experienced is 30 to 33^0 C for (air) and 28-29^0C (sea water) for most part of the year. A high cloud cover and wind energy that occurs during the South-East Monsoon period, decrease temperatures up to 25^0C for sea water and 24^0C for air, Muthiga 2001, attributes that enhance the appeal. Similarly, though the local variability of the current patterns has not been studied, lagoon currents are known to be weak, Munga et al., 2006; making planning for tourist tours and on-water activities very favourable. Kisauni and Diani are also largely located in

the coastal lowland belt, availing extensive flat areas –suitable for the easy development of human settlements and tourist facilities. Topographically, a slope that is predominantly inclined ocean-ward, encourages pollutant transport and discharge into the marine environment. Also, with an underlying basement rock that is coral, there is excellent recharge of the underground aquifers from rainwater, availing abundant groundwater sources that the residents have tapped through shallow wells and boreholes. However, behind the quick recharge, is also the potential for contamination of the water aquifers by leachates percolating down from the surface.

The Population and Housing Census (GOK, 2009), places the population of Kisauni at 405,930 persons. In recent times, the population has experienced highest growth in 10 years, Mwaguni (2009). At Diani on the other hand, population increase has been significant in the two locations of Diani and Kinondo, Swazuri, (2001), as these areas offer cheap residential housing and are near to the job opportunities and business offered by the tourism industry. The increase of population in both areas is attributed to natural growth and immigration of labour force. Since the waste load generated correspond to population numbers, it expected that the waste load will similarly increase with increasing population. This will undermine sustainability of tourism, an industry that thrives in aesthetically favourable environments with plentiful supplies of clean drinking water and clear beach waters for on-water recreational activities.

As observed in the two locations, significant land use changes have taken place with tourism and urbanisation, eclipsing the traditional economic sectors of fishing and agriculture. As a result hotels, restaurants and human settlements are now the main features that characterize the areas. Between these two areas are therefore 55 star-rated beach hotels, as well as apartment villas, guesthouses and cottages, CDA, (1996) & CDA and IUCN, (2002). See Fig.1 below which shows the land-use patterns for the two study areas. To enjoy the facilities, tourist arrivals in Kisauni increased by 40 percent between 1989 and 1993, with Diani reporting similar increases, until after 1994, when the industry started to experience a decline, with the fatal blow coming in 1997, when civil strife at Likoni brought the industry onto a literally standstill, CDA, (1996). Tourist arrivals started to pick up in the year 2002, and continued to thrive until 2013, when another dip in tourist arrivals was experienced. Since then, the industry has been at its knees, with the decline associated with insecurity and advisories delivered at source markets, where governments inform their subjects not to travel to these areas. Such events affect the economic activities that depend on tourists for their operations such as cottage industries selling artifacts, tour operations, salon and boutiques, entertainment houses, safari guiding, and boat operations.

Apart from tourism, construction of the Nyali Bridge in the early 1980s opened up Kisauni to the rapid growth of human settlements. The ease of access provided by the bridge and availability of large empty tracts of open land, not only made it conducive to development of low density housing, but also the mushrooming of the informal settlement, resulting in very high population densities. In Diani, the pattern of human settlement aligned itself not only towards the availability of infrastructure and services, but also by the land tenure system. These developments took place without adequate investment in sewage infrastructure. Consequently, sewage is managed through on-site sanitation, where the use of the pit latrine, followed by the septic-tank soakage-pit system, and sewage treatment plants. The pit latrine are used in the informal settlements, while the septic tank and soakage pit dominate the planned areas of housing and most of the hotels. Only few of the beach hotels have treatment plants. A link between excreta disposal and water pollution, as manifested by water borne diseases is obvious, and therefore it is important to appreciate the human waste management practices in the two areas in order to recommend for control measures as a way of sustaining the human settlements and the tourism trade.

2 Materials and Methods

Several methods were used to generate the information required in the study. They included: 1) field visits to identify, locate and map the human settlements and tourist establishments, and through observations to establish how they manage human waste; 2) application of the World Health Organization (WHO 1989) rapid assessment methods for land, air and water pollution to determine the potential loads of the human waste generated –noting the corresponding waste load factors; 3) review of official government records for information on population figures for the respective satellite urban areas, and the number of tourists and the bed-nights spent from hotel records. As the waste load factors used could vary, and their accuracy depending on the nature of the waste generating source and treatment mechanisms, the factors selected in this study represent as much as possible, average or typical conditions, and the assessment procedures used therefore are expected to produce results that are accurate for management purposes.

3 Results and Discussions

This section presents the findings on the alignment and spread of the human settlements relative to the hotel clusters doting the shoreline, the waste loads generated, and management practises with requisite conclusions drawn and recommendations made.

Figure 1: Spread and Location of Human Settlements and Beach Hotels (place the figure number and title at the bottom of the figures)

Fig.1a
Kisauni, Mombasa

fig.1b
b) Diani, Kwale

3.1 The Human settlements and Beach hotels

The major human settlements in the Nyali-Bamburi-Shanzu start with Shanzu, serving Serena and Shanzu beach hotels; Bamburi and Mwembe Legeza estates are aligned to Giriama Apartments, Ocean View Cottages, Bamburi resort and White Sands; Kisauni Estate is aligned to Silverstar Beach; Kongewea Estates serve, Reef, Bahari, Silver and Nyali Beach hotel; Figure 1 (a). In Diani-Chale, Gombato was aligned to take advantage of Indian Ocean Beach Club, Southern Palms Beach hotel; the Ukunda housing estates serve Diani Palm Resort, Leopard, Leisure, Kaskazi, Trade Winds and Diani Sea Resort Beach hotels. Diani propoer serves Moana, Two Fishes and Jadini Beach hotels, Mwabungo's new developments aligned themselves to take advantage of Nomad, Safari Ocean Village, Pappilon and Lagoon Reef, Baobab Resort and White Rose Villars. Finally, Kinondo was to benefit from Neptune, Paradise Village, Pine Woods Village and Chale Club, Figure 1 (b). These settlements, categorized into informal, low, middle and high cost residences were aligned inland, mostly, perpendicular to the beach hotel clusters in the shoreline. Most of the informal housing is unplanned, and occupied by squatters. Initially evenly scattered, the settlements have since merged into continuous chains of residences, Muthiga, (2001). Though different housing types' exist, the Swahili type is the dominant, and straddles all the levels of low, medium and high cost housing. This housing type is found in both study areas, and for the NBS study area, commonly distributed on both sides of the Mombasa-Malindi road from VOK in the Nyali, Bamburi and the Shanzu beach stretch up to Shanzu. Occupying up to the third row of the beach-line, this type of residence, ceases and only to be replaced by the high cost residences of the conventional type in the second and first beach rows of the coastline. While official statistics indicate that between 30% and 40% of the study area's population occupy the settlements, UNEP/FAO/PAPRAC/CDA, (2000); field evidence, Swazuri (1999) showed the percentage to be 60%, with Mwaguni (2008), placing it at about 75%.

In Diani, while most of the human settlements are found along the Mombasa-Lungalunga road, some straddle along either side of the road between Maweni and the beach road, which serves the various hotels. Some

residences are found along the coastline itself, including those from the Kongo Mosque to Chale Island, Swazuri (2001). Other high population areas include the settlement schemes of Diani and Ukunda, and the Gombato, Kinondo, Makongeni and Magaoni trust lands. Here, it is observed that the Swahili houses are interspersed with the conventional houses.

Of the 50 plus hotels found in the two areas, thirty one are located in the Nyali-Bamburi-Shanzu stretch, straddling the Kisauni, Kongowea and Bamburi locations. In Bamburi location is the Bamburi and Kenyatta beaches. These two beaches host a majority of the hotels, followed by the Nyali beach in Kongowea location, which houses the oldest, and famous of the hotels –the Nyali Beach. In Diani, twenty six major tourist hotels stand. With only three hotels found in Kinondo location, the rest are heavily found in the Diani location.

The hotel establishments and the human settlements generate loads of human waste that need to be managed prudently, if, the human habitations are to be conducive for habitation by human beings, and the beach hotels, to remain attractive to visitors. In summary, the environmental quality must be protective of human health, free from the pathogens from human effluents that cause diseases.

3.2Waste Loads Generated and Management Practice

3.2.1Human waste loads Generated

The human waste load generated were calculated using the WHO (1989) rapid assessments methods using the critical parameters of: number of people resident in the area, population dynamics and the number of bed-nights spent in the tourist hotels per tourist season were used. The tourist seasons were categorized as peak tourist season, 100% bed occupancy; mid-tourist season, 40-60% bed occupancy; low season, 10-40% bed occupancy.* The population dynamics –the increase of the local population by as much as 10% in the tourist mid-season, and by almost 25% during the peak tourist season, Swazuri (2001), were factored in the calculation of waste loads for the Diani-Chale study area. Unlike Diani, which is largely dependent on tourism to prop up socio-economic activities, alternative livelihood opportunities exist in Kisauni, and therefore, the population figures did not vary with tourist seasons, UNEP/FAO/PAPRAC/ CDA, (2000), hence only bed occupancy figures were considered in calculating waste loads generated in this area. For both the study areas, the sewage disposal systems used, informed the per capita units used in the calculations. The results of waste loads for the settlements in Kisauni are given in tables 1, 2 and 3; while that for the beach hotels is given in table 4. Those for Diani are in tables 5, 6, and 7 for the settlements, and table 8 for the beach hotels, with table 9 giving the total for the two study areas.

Table 1: The distribution of sewage disposal systems with population in Kisauni –NBS study area

Disposal System	Pit Latrines	ST/SP	Sewerage	Total
% Distribution	75	25	0	100
Population Served:				
• 2004*	224,465	74,822	0	299,287
• 2005*	232,717	77,572	0	310,289[2]

* Projected Populations, 2004 and 2005, Source: Kenya National Bureau of Statistics, Coast Population Projections, (2000-2010), Mwaguni, (2008).

Tables 2: Waste Load from Domestic Sources, Kisauni-NBS study area, (2004)

Disposal/System	P(000)	BOD		SS		N		P	
		Kg/cy	*tn/y*	*Kg/cy*	*tn/y*	*Kg/cy*	*tn/y*	*Kg/cy*	*tn/y*
PL	224.5	5.1	1145	-	-	1.6	359	-	-
ST/SP	74.8	6.9	516	16.0	1197	3.3	247	0.4	29.9
Disposal site	299.3	0.018	943	-		-		-	-
Total	**299.3**		**2604**		**1197**		**606**		**30**

Source: WHO, (1989), Mwaguni, (2008).

Table 3): Waste Load from Domestic Sources, NBS study area, (2005)

Disposal System	**P(000)**	**BOD**	**SS**			**N**		**P**	
		Kg/cy	*tn/y*	*Kg/cy*	*tn/y*	*Kg/cy*	*tn/y*	*Kg/cy*	*tn/y*
PL	232.7	5.1	1187	-	-	1.6	372	-	-
ST/SP	77.6	6.9	535	16.0	1242	3.3	256	0.4	31
Disposal site	310.3	0.018	977	-	-	-	-	-	-
Total	**310.3**		**2699**		**1242**		**628**		**31**

Source: WHO, (1989), Mwaguni, (2008)

Key:

WV at dumping site = 310.3 x 175kg/cy = 54,302.5 tn/year

WV = Waste Volume; P/Latrine = Pit latrine; ST/SP =Septic Tank/Soakage Pit; D/Site = Dump Site; BOD = Biological Oxygen Demand; SS = Suspended Solids; N = Total Nitrogen; P = Total Phosphorus; Units: P = Persons; tn = tonnes; cy = capita/year; (-) = No data available. Source of per capita data, WHO (1989)

Table 4: Waste Loads from Tourist Beach Hotels in Kisauni –the Nyali-Bamburi-Shanzu study area for 2004, 2005

Waste Load	Bed-nights (000)	Waste Production		BOD		SS		N		P	
		Kg/c	tn/s	g/c	tn/s	g/c	tn/s	g/c	tn/s	g/c	tn/s
Sewage											
Low Season	146.4	-	-	19	2.8	44	6.4	9.0	1.3	1.1	0.2
• Mid-Season	276.0	-	-	19	5.2	44	12.1	9.0	2.5	1.1	0.3
• Peak Season	906.0	-	-	19	17.2	44	39.9	9.0	8.2	1.1	1.0
Refuse											
• Low Season	146.4	1.8	263.5	18+	4.7	-	-	-	-	-	-
• Mid-Season	276.0	1.8	496.8	18+	8.9	-	-	-	-	-	-
• Peak Season	906.0	1.8	1630.8	18+	29.4	-	-	-	-	-	-
Total	**1,328.4**		**2,391.1**		**68.2**		**58.4**		**12.0**		**1.5**

Source, WHO, (1989), Mwaguni, (2008)

The number of beds in the Nyali-Bamburi-Shanzu beach hotels is 6,000.

Average Bed Occupancy: Low Season (LS) = 20%; Mid-Season (MS) =50%; Peak Season (PS) =100%Low Season occurs between April and July (122 days); Mid-Season between August and October (92 days); Peak Season between November and March (151 days); + Units: kg/tn

Table 5: The Distribution of sewage disposal systems with population, Diani study area, 2004 and 2005

Disposal System	Pit Latrines	Sep Tank/Soak Pit	Sewerage	Total
% Distribution	85	15	0	100
Population Served:				
(Year 2004)				
• Low-Season	65,542	11,566	0	77,109
• Mid-Season	72,097	12,723	0	84,820
• Peak-Season	81,928	14,458	0	96,386
(Year 2005)				
• Low-Season	67,249	11,869	0	79,117
• Mid-Season	73,975	13,921	0	87,029
• High Season	84,062	14,834	0	98,896

Tables 6: Waste Load from Domestic Sources, Diani, 2004.

D/System	P(000)	BOD		SS		N		P	
	2004	Kg/cy	tn/s	Kg/cy	tn/s	Kg/cy	tn/s	Kg/cy	tn/s
P/Latrine									
>LS	65.5	5.1	111.7	-	-	1.6	34.9	-	-
>MS	72.1	5.1	92.4	-	-	1.6	29.0	-	-
>PS	81.9	5.1	173.5	-	-	1.6	54.4	-	-
ST/SP									
>LS	11.6	6.9	26.7	16.0	61.9	3.3	12.8	0.4	1.5
>MS	12.7	6.9	22.0	16.0	51.1	3.3	10.5	0.4	1.3
>PS	14.5	6.9	41.6	16.0	96.3	3.3	19.9	0.4	2.4
D/site									
>LS	77.1	.018	27.0	-		-		-	
>MS	84.8	.018	16.9	-		-		-	
>PS	96.4	.018	52.3	-		-		-	
Total			**564.1**		**209**		**162**		**5.2**

Source: WHO, (1989), Mwaguni, (2008)

NB: Waste Volume (WV) at dump site/season is calculated by using the formula: P x 175kg/cy x n/N; Where: P = population during the tourist season; n = number of days in the season, and N = number of days in the year.

This translated into the following Waste Volumes per tourist season for the year, 2004 that were eventually used to calculate the BOD loads using the factors given in Table 6, is 4,498 tonnes for the low season, 3,730 tonnes for the mid-season and 6,994 tonnes for the peak season.

Table 7: Waste loads from Domestic source Diani-Chale for the year 2005: -

D/System	P(000)	BOD		SS		N		P	
	2005	Kg/cy	tn/s	Kg/cy	tn/s	Kg/cy	tn/s	Kg/cy	tn/s
P/Latrine									
>LS	67.2	5.1	114.5	-		1.6	35.9	-	
>MS	74.0	5.1	95.1	-		1.6	27.3	-	
>PS	84.1	5.1	177.4	-		1.6	55.7	-	
ST/SP									
>LS	11.9	6.9	27.4	16.0	63.5	3.3	13.1	0.4	1.6
>MS	13.9	6.9	24.2	16.0	55.9	3.3	11.6	0.4	1.4
>PS	14.8	6.9	42.2	16.0	98.3	3.3	20.2	0.4	2.4
D/site									
>LS	79.1	.018	83.3	-		-		-	
>MS	87.0	.018	69.1	-		-		-	
>PS	98.9	.018	128.9	-		-		-	
Total			**762**		**215**		**164**		**5.4**

Source, WHO, (1989), Mwaguni, (2008)

The Waste Volumes per tourist season generated by the local population as given below were used to calculate the BOD loads given in table 7. The waste volumes calculated for the year 2005 are 4,627 tonnes for the low season; 3,838 tonnes for the mid-season; and 7,160 tonnes for the peak season. The total waste loads for the years 2004 and 2005 are given in Table 8, while the total for both study areas is given in Table 9.

Table 8: Waste Loads from Tourist Beach Hotels in the Diani-Chale study area, 2004 and 2005

Waste Load	Bed-nights (000)	Waste Production		BOD		SS		N		P	
		Kg/c	tn/s	g/c	tn/s	g/c	tn/s	g/c	tn/s	g/c	tn/s
Sewage											
• Low Season	162.7	-	-	19	3.1	44	7.2	9.0	1.5	1.1	0.2
• Mid-Season	306.8	-	-	19	5.8	44	13.5	9.0	2.8	1.1	0.3
• Peak Season	1007.2	-	-	19	19.1	44	44.3	9.0	9.1	1.1	1.1
Refuse											
• Low Season	162.7	1.8	292.9	18^{+}	5.3	-	-	-	-	-	-
• Mid-Season	306.8	1.8	552.2	18^{+}	9.9	-	-	-	-	-	-
• Peak Season	1007.2	1.8	1812.8	18^{+}	32.6	-	-	-	-	-	-
Total	**1,476.7**		**2,658.0**		**75.8**		**65.0**		**13.4**		**1.6**

Source, Mwaguni, (2008)

The number of beds in the Diani-Chale beach hotels is 6,670, Average Bed Occupancy: Low Season (LS) = 20%; Mid-Season (MS) =50%; Peak Season (PS) =100%,

Low Season occurs between April and July (122 days); Mid-Season between August and October (92 days); Peak Season between November and March (151 days); $^{+}$ Units: kg/tn

Table 9: Total Waste Loads Generated in the two study areas in 2004 and 2005

Waste Load	BN & Population (000)	Waste Production	BOD	SS	N	P
		tn/y	tn/y	tn/y	tn/y	tn/y
N-B-S (2004)						
Beach Hotels	1,328.4	2,391.1	68.2	58.4	12.0	1.5
Local Population	299.3	52,378	2,604	1197	606	30
Total		***54,769.1***	***2,672.2***	***1,255.4***	***618***	***31.5***
N-B-S (2005)						
Beach Hotels	1,328.4	2,391.1	68.2	58.4	12.0	1.5
Local Population	310.3	54,303	2,699	1,242	628	31
Total		***55,694***	***2,767***	***1,300***	***640***	***32.5***
Diani-Chale (2004)						
Beach Hotels	1,476.7	2,658.0	75.8	65.0	13.4	1.6
Local Population	86.1	15,068	564.1	209	162	5.2
Total		***17,726***	***639.9***	***274***	***175***	***6.8***
Diani-Chale (2005)						
Beach Hotels		2,658.0	75.8	65.0	13.4	1.6
Local Population	1,476.7	15,453	762	215	164	5.4
Total	88.3	***18,201***	**837.8**	***280***	***177***	***7.0***

Source, Mwaguni, (2008)

For both study areas, more waste load is generated during the long dry season, corresponding to the high tourist season. It is also during this period that the population of both the local people and the tourist is at its peak. When the waste load generated in the two tourist establishments is compared to the total waste load

generated in the respective areas, it is found that for the NBS study area, tourism establishments contribute 4.3%, while it's associated human settlements and activities generate 95.7% of the total waste load. In Diani-Chale, the tourist establishments contribute about 14.6%, and the associated human settlement and activities 85. 4%. The tourism contribution to the waste load is about 3.4 times more for NBS than Diani-Chale. Waste generation is basically a problem of coastal settlement settlements in the urbanization process. However, where tourism fires urbanization, then the industry takes responsible for the growth of the human settlements –as is the case in Diani-Chale. In the Nyali-Bamburi-Shanzu, the industry shares the blame of promoting urbanization with other sectors of the economy.

3.2.2Waste Management Practice

In the two study areas, sewage is largely managed on-site using pit latrines (drop and store), or through the septic tank/soakage pit system (flush and discharge). The pit latrine serves between 75 to 85% of the population, making it the most predominant. The flush and discharge system serves between 16-24% of the residents, Mwaguni (2008). The type of system in use is determined by the level of development of the area, with almost all beach hotels using the septic tank-soakage pit system. The same applied to most developments near, and along the beach line, while most of informal housing, used the pit latrine. There was no evidence of direct discharge of sewage by the hotel establishments or the human settlements. On the contrary, the hospitality industry is leading the way on human waste management by investing resources on sewage treatment plants. The Severin Beach hotel, offers such an example. It uses a mechanized biological waste treatment plant, while Travellers Beach Hotel uses waste stabilization ponds. These hotels also contribute to water conservation as they recycle the wastewater for watering their gardens. In the Diani-Chale the Robinson Baobab hotel uses waste stabilization ponds and also recycles the wastewater, while a small section of the beach road is served with a conventional sewerage system; none of this exists in the Nyali-Bamburi-Shanzu.

In the informal settlements,' the pit latrine is almost exclusively used for the containment of human wastes. This notwithstanding, some Swahili households –those built according to approved village layout plans, use septic-tank/soakage pit systems. In this type of housing, the sewage infrastructure is generally, well maintained. In these settlements, however, the soak pits have been dug to the water table to prevent quick filling on use. This scenario has implication for groundwater quality through contamination of the aquifers by human wastes. It was similarly observed as a common feature in the planned Swahili housing settlements that, within households, shower-rooms were located next to the soak pits for black water, and the grey water from the showers was directed into the toilet pit. The grey water draining into pits made the black water soak pits wet –a situation that easily promoted the transport of contaminants' into groundwater aquifers. In the informal settlements, however, the pit latrines are shallow and prone to flooding –posing potential threat to water contamination by fecal matter.

For the low-cost, high-density housing settlements –including the government-housing schemes: the communal septic tank and soakage pit system is utilized. In some of these housing schemes, the septic tanks are not as tight as required by design standards, Mwaguni, (2008), and, the emptying of the soakage pits is not necessarily done in time. Only after first-signs of overflows, were the soak-pits emptied. The sewage system in this category of settlements' was poor and prone to blockages, resulting in on-ground surface flows with the consequent to land contamination and consequent threat to environmental quality and public health concerns.

In the middle-cost, high-density settlements' mostly found in both study areas, sewage is managed through septic-tank and soakage-pit systems only. The systems are either communal, where a whole estate shares one large septic tank with several soak-pits; or private, where each household had its own system. The later was the most common, and where this was the case, the systems were well maintained. Unfortunately however, just as for the planned Swahili housing and the low-cost housing residences, soak pits had been dug to the water table, compromising groundwater quality.

For the high cost, low-density housing settlements' –the affluent areas located near the coastline of both study areas, sewage was managed using individual septic tanks and soak pits. The systems were well maintained and functioned well. Similar for these areas, as was the case in the other housing types, the soak pits were also dug to the water table. This being an area of coral geology, groundwater movement is through cracks and fissures, which also provides a recipe for contaminants to enter fresh water aquifers underground, and also spill over into the recreational water of the lagoons.

As for the beach hotels, the septic-tank/soakage pit system was the choice system for containing human wastes. The system was all through located away from the beach front; and separate pits were used for black water, grey water and wastewater from laundry. And as was the case in the nearby human settlements, the pits penetrated the ground to the water, similarly, exposing waters of the nearby lagoons to potential contamination and by wastewater.

When the onsite sanitation pits were filled up, emptying was done either manually or through the use of suction pumps and stored in mobile tracks, ready for disposal in designated areas. In the informal settlement segments, sludge was traditionally removed using small containers, transferring it into drums, and transporting it to designated disposal sites. In the planned settlements, the emptying of septic tanks and soak-pits was generally

accomplished through suction trucks contracted for this purpose. Disposal of the human waste sludge was at sanctioned official sites, which is not sanitary disposal, but crude dumping on the ground surface.

4.Conclusions

The human settlements in both areas are located perpendicularly inland to the hotel clusters along the beachfront. This shows a correlation between the settlements and the hotels, where the former were strategically placed to take advantage of the employment and economic opportunities, arising from later. Similarly, whereas the growth of human settlements in Kisauni is attributed to tourism and other sectors of the economy, in Diani, it is different as tourism was solely the driving firing the growth of the human settlements.

The human waste loads generated mirror the population numbers of both residents and tourists visiting these areas. For example, owing to the large number of its population, Kisauni, generate more human waste than Diani. Relative to population however, Diani generates almost 3.5 times more than Kisauni. The sanitary methods used for human waste management in the two areas is largely on-site, and is dominated by the use of use of pit latrines in the informal settlements; the septic tank and soakage pit system in the areas of planned development, and in the beach hotel establishments. Some beach hotels –notably Severin, Travellers and Baobab treat human wastes variously. This by implication means the human waste is disposed with underground.

Pit latrines are considered inferior systems for managing human wastes, UNDP/SIDA, (2001). Only in rural areas, is this system judged to be sound as such areas are characterized by low population numbers and density. In the densely populated slum areas, the use of pit latrines is disastrous since the pits are shallow and often prone to flooding. They, in effect become point sources of contamination to both groundwater aquifers, and through run-off: the sources of contamination to surface water sources.

Similarly, owing to the high density of the human settlements, the requirement that “pit latrines shall be located at least 50m away from the nearest water source”, as the design standard (Pacey 1978), could not be observed in the characteristic setting of the urban nature of the two areas. Compounding this, was the historical development of human settlement patterns in the Kenya coast as closely dictated by land tenure system –that has resulted in squatter status for most residents. As such, squatters had no incentives to invest on land they do not own. This notwithstanding, since a healthy environment is a human rights issue and a prerequisite for good human health and the promotion of tourism, it is important the squatter issue is addressed to offer long-term protection to the environment and protect water quality from human waste discharges.

The septic tank-soakage pit system, on the other hand, when well designed, and maintained to standard requirements –offers superior service, providing efficient primary treatment of human wastes. This observation is true only in the human settlements that were privately owned. However, in housing estates where the systems were communal and managed by the local government, the situation was just as bad as it was in the slum areas, where it was otherwise worse.

Finally, the precautionary principle demands that time has come when consideration is given that large quantities of polluting material can no longer be dumped without informed knowledge as to the consequences to arise therefrom. This warning had been sounded earlier, Evans (1970). However, four plus decades later, the problem persists and is being compounded by lifestyle changes that impact both the environment and water quality so badly that costs to public health and economic development are increasing, Mwaguni (2008). As the human settlements and tourism development cannot be sustained under these conditions, there is need to provide adequate infrastructure in new areas with tourism development potential order to mitigate against passing this problem into such otherwise would-be pristine environments not to otherwise duplicate the situation as mirrored by two study areas.

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